

## The Impact of Human Capital on Economic Growth: The Case of Selected Arab Countries

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### Abstract

The overall objective of this article is to investigate the impact of human capital on the economic growth of selected Arab countries, including Sudan, during the period of 1990 to 2010. The study makes use of panel data, and estimates an aggregate production function using a fixed effects model. The basic macroeconomic variables of concern derived from the literature review include the real gross domestic product, capital stock, the labor force, and gross enrolment in primary, secondary and tertiary education levels. The results reveal that human capital development – secondary and tertiary education levels – has a significant impact on the economic growth of Arab countries.

**Keywords:** *Education, Human capital, Economic growth.*

### Abstrak

Objektif umum makalah ini ialah untuk mengkaji impak modal insan ke atas pertumbuhan ekonomi dalam kalangan negara Arab terpilih, termasuk Sudan dalam tempoh tahun antara 1990 hingga 2010. Kajian ini menggunakan data panel, dan penganggaran dibuat melalui fungsi pengeluaran agregat menggunakan model *fixed effects*. Pemboleh ubah asas makroekonomi yang menjadi tumpuan kajian diperolehi daripada kajian lepas, iaitu keluaran dalam Negara kasar benar, stok modal, buruh, enrolmen kasar pendidikan peringkat rendah, menengah dan tertiar. Hasil kajian menunjukkan bahawa pembangunan modal

insan iaitu melalui pendidikan peringkat menengah dan tetiari – mempunyai kesan yang signifikan terhadap pertumbuhan ekonomi dalam kalangan negara Arab.

***Kata kunci: pendidikan, modal insan, pertumbuhan ekonomi***

## 1. Introduction

The models of economic growth aim to discover the productive factors that might contribute to an increase in the economic productivity and generate sustained growth. The recognition of these factors is not always universally agreed but divides opinions between the relative importance of each productive factor, as well as the particular way in which each factor participates in the economic growth.

In this respect, human capital is no exception. Undoubtedly, there exists a relationship between economic development and human capital; an inference can be drawn that supports the evidence that the most developed societies are also the ones that have a higher level of education in their population. However, empirical studies do not always support a positive and significant relationship between human capital accumulation and economic growth.

Models of economic growth treat human capital in two main forms: on the one hand the productive factor is considered as being similar to physical capital, technology and labor; while on the other hand, it is accepted as a factor that facilitates the acquisition of technology. Human capital is a crucial productive factor in neoclassical models of exogenous growth, such as shown by the model of Mankiw et al. (1992) and also in the endogenous growth models of Lucas (1988). Other endogenous growth models, such as those of Nelson and Phelps (1966), Romer (1986-1990a, b), and Benhabib and Spiegel (1994), consider that human capital accumulation facilitates the adoption, creation and diffusion of technology.

Despite the relative consensus in the theoretical interpretations of the relationship between human capital accumulation and economic growth, there is a large controversy surrounding the empirical findings. In international literature, we can consider three types of conclusion for the empirical studies: (i) studies that consider human capital accumulation is essential for economic growth; (ii) studies that sustain the assumption that human capital accumulation is not capable of explaining the differences in the income per capita distribution on a world scale; and (iii) studies that consider that human capital accumulation is the result of economic growth. Although these mixed findings are justified by economists for different reasons, the most important are: (a) misspecification of the models, (b) measurement errors in education data, and (c) the selected proxies for human capital.

This study examines the contribution of human capital to economic growth in selected Arab countries for the period of 1990 to 2010. The interest is to investigate whether the witnessed expansion in education enrolment at all levels has a substantial impact on the economic growth of these countries. In other words, the question is to what extent Arab economies experienced an improvement in their economic performance for the period under consideration. In answering this question, and like many other studies, the analysis had to confront the problem of weak databases. To overcome some of these problems, two steps were taken. First, the sample was reduced to 10 countries for which sufficient data were available. Second, a number of proxies were derived to substitute for direct measurements of certain variables.

This work is organized as follows. Section 2 presents the literature review. Section 3 explains the economic structure of the Arab countries. A brief discussion on educational achievement in Arab countries is outlined in section 4. The model specification, variables

definition and measurement are illustrated in section 5. The results and their analyses are presented in section 6, while section 7 concludes the paper.

## **2. Literature Review**

The growth theory tries to explain the trend growth rate of total output per capita in an economy. Two sources of growth can be distinguished: (i) growth that is accounted for by the increase in quantity of factor inputs (capital and labor); and (ii) growth that is explained by the increase in efficiency in the use of inputs. The latter source of growth is labeled as total factor productivity (TFP). Often referred to as "technology", TFP encompasses all methods used to produce goods and services. Improvements in technology raise the productivity of all factors of production, and, thus, also raise total output. Growth based on an increase in factor inputs is sometimes called "extensive growth", whereas growth based on TFP is called "intensive growth".

The recognition of sources of growth is an important element from the perspective of neoclassical growth theory, which emphasizes the effect of increases in TFP (or, in other words, technological progress) on sustained long-term growth. Specifically, policies that influence the accumulation of knowledge and technology have long-run effects on economic growth. Policies that only support extensive growth, i.e., the accumulation of physical capital, tend to have a more limited effect in the long-run given the declining marginal productivity of capital. Recent developments in growth theory, focusing on endogenous growth models, have provided other important insights. In some models, government policies that support the accumulation of physical capital can have a permanent influence on the rate of growth. Nevertheless, intensive growth based on increases in TFP remains the core of long-run economic growth and has not lost its relevance.

Unlike in neoclassical growth theory, in which TFP growth is exogenously given, endogenous growth models aim at illustrating the conditions under which economic units face positive incentives to increase their knowledge and/or productivity, the mechanisms through which these increases are diffused in the economy, and the conditions under which they raise the rate of long-run growth. In this sense, the identification of total factor productivity remains an important element in the empirical assessment of long-run economic growth even in light of the most recent theoretical developments. In the most basic form, growth accounting exercises are based on the Cobb-Douglas production functions. In fact, data on education is seldom available in annual periodicity. This is probably one of the reasons why cross-country regressions have been the main empirical tool in this field. Empirical research on the impact of human capital (education, for example) on growth has progressed basically by cross-sectional regressions where the growth rate is the dependent variable, and an education indicator is one of the explanatory variables.

The number of empirical studies that include different proxies for human capital in their growth regressions is large and growing. In fact, most of these studies have adopted a somewhat narrow focus on education, or, more precisely, schooling. Among the most popular proxies for human capital are school enrolment rates (i.e., the percentage of the relevant part of the population enrolled in school) and educational attainment measured in years of schooling (i.e., the average years of formal education of the working-age population). The argument for education is that increased education produces more skilled workers and, in the end, more skilled workers increase productivity and growth. Indeed, de la Fuente-Ciccone (2002) classifies the previous studies made in this area using the econometric specification criteria. Thus, through these criteria, the studies

were classified into: (i) studies based on a convergence equation, which comprises ad-hoc specification and structural convergence equations and (ii) studies that estimated an aggregate production function. In this section, the focus will be on empirical studies based on an aggregate production function, because the current study will employ the standard growth accounting methodology with human capital, which is specified in an aggregate production function.

Recently, empirical studies moved to investigate whether different levels of education have a different impact on economic growth. For example, Lau et al. (1991) examine the impact of primary and secondary schooling on growth in five regions. Their results show that primary schooling has a negative effect on growth in Africa and the Middle East, even though the effects seem to be insignificant in South Asia and Latin America with a positive and significant effect in East Asia. Similar findings were obtained by Abbas (2001) who analyzes the contribution of human capital to economic growth in Pakistan and Sri Lanka for the period 1970 to 1994. Based on the production function framework, the selected human capital indicators are enrolment rates in primary, secondary and tertiary education. Other variables included the physical capital formation and labor forces. The results of this study showed that all education levels play a significant role in both countries except the primary level, which has a negative and insignificant effect on growth. The author justifies the negative signs for primary education level by arguing that poverty level is very high in both countries and that most of the parents send their children to work rather than putting them in school.

In contrast, Petrakis and Stamatakis (2002) show that primary and secondary education matter more for growth in less developed countries than for more developed economies, where higher education becomes more important. Papageorgiou (2003) finds that primary education is more important in final goods production, whereas post-primary education is essentially related to technology adoption and innovation. This result suggests that LDCs benefit most from the accumulation of primary education employed in final goods production. One possible explanation for this result is Rostow's development stages. Primitive economies benefit more from the accumulation of primary education as they rely heavily on final goods production. This means that primary education mainly contributes to the production of final output, whereas post primary education mainly contributes to the adoption and innovation of technology. In the same line, in Vandenbussche et al. (2006) the growth effect of skilled labor is stronger when a country gets closer to the technological frontier. Self and Grabowski (2004), in a rare country-specific time series study, investigate whether education had a causal impact on growth in India. Their analysis was done in terms of Granger's causality, finding that primary education has a strong impact on growth, while evidence for a similar effect on secondary education appears more limited.

A study by Judson (1993) revealed that primary schooling seems to have a positive impact on growth in contrast to secondary and tertiary education, which has no significant effect on growth. Additionally, Barro and Sala-i-Martin (1995) find no correlation between growth per capita, and secondary and tertiary education, while studies by Behrman (1987), and Dasgupta and Weale (1992) show that changes in adult literacy rates are significantly correlated to changes in output. Bils and Klenow (2001) argue that the correlation between schooling and growth is weak. However, Romer (2000) argues that the impact of education on economic growth is not determined by the amount of expenditure but by the quantity of inputs used in R&D.

Some critics note that correlation evidence is seldom proof of causation. Bils and Klenow (2000) provide evidence that most correlation results between education and growth could, in fact, derive from reverse causation – more growth would cause more education – and not the contrary. Temple (1999b) points out that, “the correlation between increased human capital and growth may sometimes be hidden in the cross-country data by a number of unrepresentative observations”. Krueger and Lindahl (2001) emphasize that, “the positive effect of the initial level of education on growth seems to be a phenomenon that is confined to low productivity countries”. More generally, we note that too many heterogeneous parameters lead to inconsistent estimates. For example, the fact that school quality is not constant across countries is another important source of heterogeneous parameters. Heterogeneity is likely to be reinforced if different schooling levels have unequal effects on growth. The above-mentioned limitations call for different research methods on the nexus between education and growth. Cross-country heterogeneity implies that there is much more room for country-specific studies, wherever data restrictions do not apply.

As mentioned previously, most of the empirical studies estimate an aggregate production function utilizing cross sectional data. Irrespective of why it depends on these kinds of data, today few studies estimate this function within countries, which means, employed time series' data. For instance, Adawo (2011) analyzes the contribution of human capital to the economic growth of Nigeria in the long-run during the period 1970-2006. Based on the production function framework, the selected human capital indicators are enrolment rates in primary, secondary and tertiary education. Other variables include the physical capital formation. The results of this study show that the human capital of primary schools contributes to the growth while in most cases the secondary schools and that of tertiary institutions dampen the growth. Above all, it was noticed that in the short-run, physical capital plays a very important role in encouraging growth.

Babatunde and Adefabi (2005) investigate the long-run relationship between the education and the economic growth in Nigeria during the period 1970-2003. The investigation was made through the application of the Johansen co integration technique and the vector error correction methodology. The results of the co integrating technique suggest that there is a long-run relationship between the enrolments in the primary and the tertiary levels as well as the average years of schooling with the output per worker. The two channels through which human capital can affect growth were analyzed. Although, it may be difficult to separate the two different channels from each other, the results reveal that a well-educated labor force has a positive and significant impact on the economic growth through a factor accumulation and on the evolution of total factor productivity. The good performance of an economy in terms of per capita growth may therefore be attributed to a well-developed human capital base.

We can conclude from this discussion that although these mixed findings are justified by the economists for different reasons, the most important are: (a) mis-specification of the models (b) measurement errors in education data, and (c) the selected proxies for human capital.

### **3. The Economic Structure of Arab Countries**

Arab countries exhibit great diversity in their economic structure. For example, according to the Economic Research Forum (ERF: 1998), Arab countries could be grouped into four broad categories: mixed oil producers (MOP) including Algeria, Libya and Iraq; the Gulf Cooperation Council (GCC) including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates

(UAE); diversified economies (DE), which include Egypt, Jordan, Morocco, Lebanon, Syria, and Tunisia; and primary producers (PP) including Comoros, Mauritania, Sudan, Djibouti and Yemen. In this study the selected sample include a mix of countries related to differences in their economic structure. For example, one country (Algeria) belongs to (MOP), two countries (UAE and Oman) are related to (GCC), one country (Sudan) is related to (PP) and the remaining six countries are related to (DE).

According to available information (see table 1 below), in 2007, the Arab world produced goods and services worth US\$ 587.5 billion at current prices. This amounts to a per capita GDP of US\$ 6954.04312 per annum. This average, however, conceals significant variations among countries and sub-regional groups. At the country level, per capita GDP varied from a high of US\$ 21133.35108 for Oman, to a low of US\$ 1878.616769 for Sudan. At the sub-regional level, per capita GDP for all Arab countries (6954.04312) is greater than that of low-income countries (1018.028931), and, at the same, time lower than that of the world (9535.39788). Also the share of investment to DGP (gross fixed capital formation) varies among the countries and sub-regional groups. At the country level, for example, the share varied from a high 31% of GDP for Morocco, to a low of 19% of GDP for UAE. At the sub-regional level, the share of investments to GDP in all Arab countries is, to some extent, similar to that of the low-income countries and the world (22% Of GDP for each).

From the economic sector components perspective the share of agriculture value added as a percentage of GDP is higher for Sudan with 28% of GDP and lower for UAE with less than 2% of GDP. In fact, agriculture value added % GDP for Sudan, which corresponds to its 28% share in low-income countries, which is quite different from that of the 2% GDP for the world. For the all sample the manufacturing value added is less than 20% of GDP and the highest percentage recorded is for Jordan (20% GDP) while the lowest share recorded is for Algeria (5% GDP). Although there is a slight difference in the share of manufacturing value added between all Arab (11% GDP) and low-income countries (12% GDP), it is the share in the world GDP (17%) that is relatively higher. Industry value added constitutes a higher share of GDP for both UAE and Algeria with a share of 61% and 60%, respectively. In contrast it has a lower share in other countries, for example, 27% for Morocco. Indeed the share of industry value added in GDP in all Arab countries (52%) is twice that of both low-income countries (25%) and the world (27%). Regarding the share of the services sector in GDP, within the selected sample, Lebanon has the highest share (71%) while at the same time Algeria has the lowest share (30%). At the sub-regional level, all Arab countries have a lower share of services value added in GDP (40%) compared to that of low-income countries (48%) and the world (69%). Egypt has a larger labor force (25 millions), which constitutes 23% of the total labor force in all the Arab countries (133 million). At the same time Lebanon has a smaller labor force (1.300 million) constituting about 0.0122 % of the total labor force Arab countries.

We can conclude from the above information, in terms of the share of the various sectors to total GDP, there is a variety within the selected sample and among sub regional countries. For example, countries like Algeria and UAE are largely reliant on the industry sector; while countries like Lebanon and Sudan rely on the services and agriculture sectors, respectively. Among the sub regions, the industry sector plays a significant role in the contribution to the GDP in Arab countries, while this role is associated with the service sector in the low-income and world countries.

Table 1: Sectoral Share in selected Arab countries and sub regions, 2007.

Countries	Gross fixed capital formation (% GDP)	Agriculture Value added (% GDP)	Manufacturing Value added (% GDP)	Industry Value added (% GDP)	Services Value added (% GDP)	Total Labor Forces	Per capita GDP (PPP constant US\$ 2005)
Algeria	25.98165801	8.025345596	5.276533671	61.28300683	30.69164758	14079507.62	7315.592966
Oman	-	-	-	-	-	-	21133.35108
UAE	19.48051948	1.795258325	12.40235713	60.60024668	37.604495	2730122.163	52944.2007
Egypt	20.85202194	14.07021828	15.68546302	36.34452004	49.58526168	25768389.51	4762.117022
Jordan	26.14657475	2.725153626	20.36067294	30.3145547	66.96029161	1799251.989	4840.202203
Lebanon	26.8101554	7.119005151	10.38643797	21.87555642	71.00543843	1390851.94	10110.9297
Morocco	31.24896552	13.73079735	15.04032487	27.31425912	58.95494353	11578297.34	3776.135688
Syria	21.64623074	18.1151044	11.7412068	34.95334111	46.93155449	6486626.042	4123.123446
Tunisia	23.18716071	10.17188743	16.86942648	29.13648647	60.6916261	3716478.865	7101.778766
Sudan	26.53662519	28.12590981	6.059860366	31.18409576	40.68999443	12698382.89	1878.616769
Arab countries	22.8609098	7.35588091	11.156594	52.0765457	40.5666497	113543605	6954.04312
Low-Income Countries	22.14825398	26.23775391	12.60569688	25.3282108	48.61200273	364139989.4	1018.028931
World	21.6597724	2.95176585	17.2301595	27.6494683	69.4167164	3082232382	9535.39788

*Source: World Bank database.*

#### 4. Educational Achievement in Arab Countries

Another dimension of diversity in Arab countries is related to educational achievement, which is reflected by the information in Table 2 below. Comparing among Arab countries, low-income and the world countries, the table shows that the gross enrolment in primary level in all the countries in the sample except for Sudan and Oman, enjoyed better-than-average educational achievement than the other sub regions. The best performing Arab country in terms of this indicator is Syria with a gross enrolment ratio of about 125 percent, followed by Algeria (110%) and UAE, Tunisia and Morocco with (107%) each. The worst performing is Sudan (68%), followed by Oman (85%). In secondary education achievement, the table indicates that except for Sudan all the countries enjoyed a better education achievement than the low-income countries. Furthermore, all the countries in the sample except Morocco and Sudan enjoyed better than the average of the Arab and world countries.

Concerning the gross enrolment in the tertiary level, comparing the sample of countries with the average educational achievement in all Arab countries (22%) the table shows that half of these countries enjoyed more than the other two sub regions. The best performing Arab country in terms of this indicator is Lebanon with a gross enrolment ratio of about 48% percent, followed by Jordan



(37%), UAE (29%) and Egypt (28%). The worst performing is Sudan (2%); followed by Oman (2%), Morocco (11%), Syria (17%) and Algeria (21%). While the achievement in these countries compared with low-income countries indicates that with the exception of Oman and Sudan all the remaining countries have a better gross enrolment at the tertiary level than the low-income countries. In 2007, all the selected countries had a better achievement in this level of education compared to the average world achievement except for Algeria, Oman and Sudan.

Table 2: Education Achievement in selected Arab countries and sub regions, 2007.

Countries	Gross enrolment in primary level	Gross enrolment in Secondary Level	Gross enrolment in Tertiary Level
Algeria	110.453	84.56065	21.82554
Oman	85.65166	89.44516	2.83E+10
UAE	107.9386	93.76732	29.46306
Egypt	98.41443	85.24927	28.71888
Jordan	96.29589	86.34057	37.72866
Lebanon	100.2651	82.3788	48.97895
Morocco	107.2411	55.84502	11.30569
Syria	125.2201	71.9023	17.48768
Tunisia	107.6101	90.20627	31.57614
Sudan	68.65219	31.77361	2.483244
Arab countries	93.0212656	64.239334	22.6244108
Low-Income Countries	101.663574	36.271795	5.81013993
World	103.975251	66.4879489	25.8227586

Source: World Bank database.

## 5. Model Specification, Variables Definition and Measurement

This study makes use of panel data, which is formed by pooling the time series, cross-section data of ten Arab countries for the period 1990-2010. These countries comprise Algeria, Oman, UAE, Egypt, Jordan, Lebanon, Morocco, Syria, Tunisia and Sudan. The use of panel data is believed to be appropriate because of the limited number of observations for each country. Panel data sets are

typically wide but short, i.e., with wide cross sectional units but a short number of years. In this study, however, because the cross sectional units are only ten – since we focus on only ten countries – the panel data formed is not the typical wide and short panel. However, the advantages here are that we reduce the large averaging effect that occurs in wide panel data sets. Thus, the estimation obtained in this study would better reflect the situation in these ten countries. There are three models that can be used for analyzing panel data. The first model is to simply combine or pool all the time-series and cross sectional data and then estimate the underlying model using ordinary least squares (this is referred to as pooled least squares). The intercept is assumed to be common. The second model involves the recognition that omitted variables may lead to changes in the cross section, and time-series intercepts. This model is referred to as the fixed-effects model, which allows for intercepts to be different for the different cross-sections. The third model allows for the variation in the cross-sections and also the periods. This method is called the random-effects. The method is essentially a variation of the generalized least squares' estimation.

Our study estimates the parameters by the log-linearized Cobb-Douglas production function. The choice of this type of production function follows the international literature on neoclassical growth models (Abbas, 2008; Adawo, 2011; Uwatt, 2002). We consider the following production function:

$$Y_{it} = A_{it} K_{it}^{\alpha} L_{it}^{\beta} H_{it}^{\gamma} e_t \quad (5)$$

Where Y is the real Gross Domestic Product, K is the physical capital, L is labor force, H is the human capital and e is the error term. Taking the log, the relation for growth can be expressed as:

$$\log Y_{it} = \log A_{it} + \alpha \log K_{it} + \beta \log L_{it} + \gamma \log H_{it} + \epsilon_{it} \quad (6)$$

$$\log Y_{it} = a_{it} + \alpha \log K_{it} + \beta \log L_{it} + \gamma \log H_{it} + \epsilon_{it} \quad (7)$$

This specification implies that the econometric estimations do not impose any restrictions on the value of the parameters (the elasticity's product-factor) in trying to get the answer to our problem from the data. Thus, we do not impose the existence of constant returns to scale as a condition for the estimation of the model. This form of estimation, on the one hand, allows us to eliminate the restrictions imposed in the returns to scale for the set of inputs considered and, on the other hand, it allows us to determine the sign of each one of the parameters of the function. Although the economic theory imposes positive values for each one of the elasticity product-factors, the empirical analysis can disclose a distinct result specific to the economy being analyzed as a fact that will be tested.

The current study follows the literature in the selection of the relevant proxies for the input variables. The study used total labor force as an indicator for labor input. In order to measure the physical capital stock, we have used the perpetual inventory method. The method moves from the assumption that the stock of physical capital (K) in a given year is equivalent to the capital stock of the previous year, net of depreciation ( $\delta$ ), plus investment (I) of the current year. In formula,

$$K_t = I_t + (1 - \delta)K_{t-1} \quad (8)$$

Since the reconstruction of the series is based on the investment process, the estimate of the initial capital stock is a crucial step. Following Harbenger (1978), we have hypothesized that capital stock at time zero is positively correlated with investments in the following year and inversely related to the average annual growth rate of GDP and depreciation rate. In formula,

$$K_t = \frac{1}{g+\delta} \quad (9)$$

Where  $g$  is the average annual growth rate of the aggregate product and  $\delta$  is the depreciation rate. It is interesting to note that this formulation coincides with the equation that defines the physical capital stock at the steady state in Robert Solow's model (1956). Data on investment (gross fixed capital formation) have been extracted from the National Accounts Main Aggregates Database of the United Nations, in US dollars and 2000 constant prices. In the absence of specific micro surveys or information about various tax legislations, the depreciation rate has been set at 10%, a choice in line with other studies, such as Bisat et al. (1997) or Abu-Quarn and Abu-Bader (2007). Regarding human capital ( $H$ ), the study employed gross enrolment in primary, secondary and tertiary levels as proxies for human capital, a choice in line with other studies, such as Abbas (2001).

## 5.1 Variables Definition and Measurement

### 5.1.1 Gross Domestic Product

PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2005 international dollars.

### 5.1.2 Labor Forces

Total labor force comprises people aged 15 and older who meet the International Labor Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed. While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector.

### 5.1.3 Real Capital Stock

The total physical capital ( $K$ ) existing in an economy at any moment of time is referred to as capital stock. For this study, data on real capital stock is derived from real capital formation at 2000 constant basic price using this formula  $K_t = \sum_{j=0}^t (1-d)^{t-j} \left( \frac{I_j}{P_j} \right)$ . Where  $K_t$  is the capital stock at period  $T$ ,  $d$  is the rate of depreciation  $I_j$  is the total investment at period  $J$  and  $P_j$  is the price level at

period  $J$ .  $I/PJ$  is the real value of the investment, in this case it is replaced by the value of real fixed capital formation. Sudan does not provide data on physical capital stock but rather data on capital formation (investment) are reported every year. For the purpose of this study, we compute real capital stock (RCS) from real capital formation using the above formula. In the absence of specific micro surveys or information regarding the various tax legislation the depreciation rate has been set at 10%, a choice in line with other studies, such as Bisat et al. (1997) or Abu-Quarn and Abu-Bader (2007).

#### **5.1.4 School Enrollment, Primary (% Gross)**

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Primary education provides children with basic reading, writing, and mathematics skills along with an elementary understanding of such subjects as history, geography, natural science, social science, art, and music.

#### **5.1.5 School Enrollment, Secondary (% Gross)**

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject-or skill-oriented instruction using more specialized teachers.

#### **5.1.6 School Enrollment, Tertiary (% Gross)**

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level.

### **6. Results and Discussion**

As mentioned earlier, there are three possible models that can be derived from the (7). They are the pooled, fixed and random models. The pooled model assumes the intercepts for the countries are identical, that is,

$$\alpha_{it} = \alpha \quad (10)$$

The difficulty with pooled least squares is its assumption of constant intercept and slope is unreasonable. The fixed effects for the model in (3) are estimated to allow for different intercepts for different cross-section units, thus:

$$\alpha_{it} = \alpha_i \text{ where } E(\alpha_i e_{it}) \neq 0 \quad (11)$$

The random effect model on the other hand treats intercepts as random variable across pool members so that:

$$\alpha_{it} = \alpha + u_i \text{ where } E(u_i e_{it}) = 0 \quad (12)$$

For our problem, we could not estimate the random effects model, as it requires balanced data. Therefore, we estimate equation (7) by employing the other two possible models (pooled and fixed effects). The results obtained from these two models indicate that this model suffers from the problem of autocorrelation. To solve this problem we introduce the first autoregressive term AR (1) to the model. The model in (7) was first estimated using the pooled least squares technique with the assumption of a common intercept and then using the fixed effects model, which allows for different intercepts representing each country. The coefficients of all the repressors are assumed to be common across the cross section units (the ten countries). The use of country dummies to obtain the different intercepts can capture, to some extent, the initial differences that exist among these countries. The results of the pooled and fixed effects are displayed in table (3) below.

Table 3: Regression results, dependent variable is Log Y

Explanatory Variables	Pooled Model		Fixed Effect	
	Specification 1	Specification 2	Specification 1	Specification 2
Constant	8.122824 (3.287349)*	5.904114 (2.504916)**	4.622781 (3.657685)*	5.323252 (4.916671)*
Log (K)	0.608048 (6.200690)*	0.607244 (6.651244)*	0.356746 (6.098387)*	0.401673 (7.110570)*
Log (L)	0.157090** (1.652383)	0.252102 (2.440804)**	0.764464 (7.046196)*	0.587449 (5.671020)*
Log(P)	-	-0.014520 (-0.087397)	-	-0.024738 (-0.307639)
Log(S)	-	0.147896 (4.023135)*	-	0.155931 (4.326559)*
Log(T)	-	0.011240 (0.862464)	-	0.072214 (2.646146)**
AR(1)	0.962670 (112.4128)*	0.958654 (101.7759)*	0.780118 (21.02481)*	0.751666 (19.96141)*
R <sup>2</sup>	0.997393	0.997579	0.997749	0.998022
R <sup>-2</sup>	0.997302	0.997503	0.997605	0.997860
F	24524.66 (0.0000)*	13186.25 (0.0000)*	6907.916 (0.0000)*	6154.884 (0.0000)*
D.W	1.484367	1.587312)	1.682873	1.726018

The *t*-statistic is in parentheses, and (\*), (\*\*) indicates significant at 1% and 5% level, respectively.

In order to test which model is better between the pooled least squares' regression model and the fixed effects model, we conduct the following F-test, where the null and the alternative hypothesis are as follows:

$$H_0: \alpha_{it} = \alpha$$

$$H_1: \alpha_{it} = \alpha_i$$

The  $F$ -test statistic is given as follows (Greene 2000: 562):

$$F = \frac{(R_{fe}^2 - R_p^2)(nT - n - K)}{(1 - R_{fe}^2)(n - 1)}; F_{n-1, nT-n-K} \quad (13)$$

The test statistics in (13) follows an  $F$ -distribution with  $(n-1)$  and  $(nT-n-k)$  degrees of freedom. The computed  $F$  statistic for model (7) is equal to 4.549774 and under this value we are able to reject the null hypothesis, which means that the fixed effects is more efficient than the pooled model. To obtain an efficient estimation for the fixed effects model it is possible to choose between two ways of estimation – i.e. estimation with the white cross section or by generalized least squares (EGLS). The selection criteria between these two ways of estimation are the goodness of fit measures, thus, estimation with the better goodness of fit must be chosen. The results of the estimation model (7) by the two estimation models are outlined in table (4) below.

Table 4: Robust Panel Model; dependent variable is Log Y

Explanatory Variables	Estimation with white cross section		Generalized least squares (EGLS).	
	Specification 1	Specification 2	Specification 1	Specification 2
Constant	4.622781 (2.857808)**	5.323252 (3.825236)*	3.775223 (2.878842)**	4.943823 (4.255662)*
Log (K)	0.356746 (4.519642)*	0.401673 (5.278877)*	0.354065 (4.687603)*	0.366099 (6.339901)*
Log (L)	0.764464 (7.927641)*	0.587449 (5.968037)*	0.824473 (6.837527)*	0.674784 (6.378798)*
Log(P)	-	-0.024738 (-0.301468)	-	-0.017082 (-0.247726)
Log(S)	-	0.155931 (3.990607)*	-	0.163564 (5.768632)*
Log(T)	-	0.072214** (2.327292)	-	0.043933 (2.096302)**
AR(1)	0.780118 (10.49750)*	0.751666 (9.720425)*	0.848377 (28.61265)*	0.831453 (26.42923)*
R <sup>2</sup>	0.997749	0.998022	0.998595	0.998710
R <sup>2</sup>	0.997605	0.997860	0.998505	0.998604
F	6907.916 (0.0000)*	6154.884 (0.0000)*	11075.04 (0.0000)*	9446.36-46 (0.0000)*
D.W	1.682873	1.726018	1.660318	1.663419

The  $t$ -statistic is in parentheses, and (\*), (\*\*) indicates significant at 1% and 5% level, respectively.

From the table above, based on the goodness fit measures ( $F$ ,  $R^2$ ,  $t$ ) we can conclude that there is a slight or no difference between the two ways of the estimation. However, the D.W. statistics indicate that the estimation based on the white cross section is relatively better than the estimation by using EGLS. Therefore, it is possible to discuss the results obtained by employing the white cross section on the two specifications. The results of the specification (1) in table (4) indicate that the model is significant at the 1% level, as indicated by the F-ratios. Furthermore, the selected variable explained an average of 99% of the variation in the real gross domestic product. The D.W. Statistics indicate the absence of any autocorrelation problem at the 5% significant level. Furthermore, both labor forces and capital stock play a positive and statistically significant contribution to the real gross domestic product. However, the elasticity of total output with respect to labor force (0.76) is greater than that of capital stock (0.35). This result means that increasing the labor force by one percent leads to an increase in the total output by 0.76 percent, while the same increase in capital stock leads to an increase in the total output by 0.35 percent. These results reflect the pattern of production (production structure) of most Arab and developing countries, which is the intensive labor production pattern and unlike the intensive capital production pattern of developed countries. Furthermore, the production function characterizes by the constant returns to scale. From the results, the sum of the variable elasticity's with respect to the total output ( $\gamma$ ,  $\beta$ ,  $\alpha$ ) is equal to 1. In other words, increasing inputs by, for example, one percent leads to increase in total output by the same rate.

The second specification illustrates the model with human capital variables. The results indicate that primary education plays a negative role for growth but statistically insignificant as indicated by the T ratio. The other two education measures play a positive and significant role in promoting growth, and secondary education has a relatively high significant role (1%) compared to the tertiary level (5%). Furthermore, the elasticity of output with respect to secondary education (0.155) is greater than that of tertiary education (0.072). These results mean that any increase in gross enrolment in secondary, tertiary education by one percent leads to an increase in total output by 0.155 and 0.072 percent, respectively. This result is similar to that obtained by Abbas (2001) and Lau et al. (1991). It is generally known that in the world, which is characterized by higher competition in the goods market, the industrial and manufacturing sectors require labor with relatively higher skills to facilitate the adoption and innovation of technology. Secondary and tertiary education provides the labor market with people who have higher and medium skills needed for the industrial sector. Therefore, the significant contribution of the post primary education to economic growth in Arab countries might be justified by domination of the industrial sector on the economic activities in these countries (52% of GDP).

The most interesting finding is that the share of the capital stock to total output is 0.35 when the education variable is excluded and 0.40 when these variables are included. Therefore, the inclusion of education seems to overestimate (although rather modestly) the relative share of capital stock to production. At the same time and for the labor forces the inclusion of education variables underestimates their share in the production from 0.76 to 0.58. These results imply that one channel through which education affects production is through making capital stock more productive and having a greater influence on total output. While the diminishing returns to output from the labor after inclusion of the education variables indicate that the influence of labor now relies on its quality and not it is the quantity. Furthermore, after the inclusion of the human capital variable to the model, the production function moved from the status of constant returns to scale to increasing returns to scale. From the results, the sum of the variable elasticity with respect to the total output

$(\gamma, \beta, \alpha)$  is equal to 1.20. In other words, increasing input by, for example, one percent leads to an increase in total output by more than one percent.

## 7. Conclusion and Remarks

The paper investigates empirically the impact of the human capital on the real total output of the sample of Arab countries during the period 1990-2010. The study makes use of panel data and estimates an aggregate production function using the fixed effects model. The basic macroeconomic variables of concern derived from the literature review are: the real gross domestic product, capital stock, the labor force, gross enrolment in primary, secondary and tertiary education levels. Data for the selected variables and for the sample of the countries were obtained from the World Bank database. The results reveal that human capital development – secondary and tertiary education levels – have a significant impact on the economic growth of Arab countries. Furthermore, after the inclusion of the human capital variable to the model, the production function moved from the status of constant returns to scale to increasing returns to scale.

Therefore, and in order to sustain this positive and significant impact of human capital to economic growth, Arab countries should continue to adopt policies that lead to an increase in the knowledge and skills within their people. These policies, for example, include: (a) increase the expenditure on education for all levels, (b) provide a facilitating and motivating environment by ensuring the establishment of macroeconomic stability that will encourage increased investment in human capital by the private sector, (c) to increase the physical capital formation in the education sector, the Arab policy makers should increase the budget on social and economic infrastructure in order to enhance the efficiency of the labor force and enhance the productivity, and, by implication, the economic growth of the country.

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